Q 68: Quantum Information (Concepts and Methods) V

Time: Friday 10:30–12:30 Location: K 1.019

Q 68.1 Fri 10:30 K 1.019

Bounds on absolutely maximally entangled states from shadow inequalities, and the quantum MacWilliams identity — •Felix Huber[1], Christopher Eltschka[2], Jens Siewert[3], and Otfried Gühne[1] — [1]Naturwissenschaftlich-Technische Fakultät, Universität Siegen, D-57068 Siegen, Germany — [2]Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany — [3]Departamento de Quimica Fisica, Universidad del Pais Vasco UPV/EHU, E-48080 Bilbao, Spain

A pure multipartite quantum state is called absolutely maximally entangled (AME), if all reductions obtained by tracing out at least half of its parties are maximally mixed. Maximal entanglement is then present across every bipartition. The existence of such states is in many cases unclear. With the help of the weight enumerator machinery known from quantum error correction and the generalized shadow inequalities, we obtain new bounds on the existence of AME states in dimensions larger than two. To complete the treatment on the weight enumerator machinery, the quantum MacWilliams identity is derived in the Bloch representation. Finally, we consider AME states whose subsystems have different local dimensions, and present an example for a 2x3x3x3 system that shows maximal entanglement across every bipartition.

Q 68.2 Fri 10:45 K 1.019

Truncated moment sequences and the entanglement problem — Fabien Bohnet-Waldraff[1], Olivier Giraud[2], and •Daniel Braun[1] — [1]Institute for theoretical Physics, University Tübingen — [2]LPTMS, University Paris-Saclay and CNRS

The "entanglement problem" is to decide whether a given quantum state of a composite system is is entangled over a chosen partition or not. We show that it can be mapped to the "truncated moment problem" studied in mathematics, for which recently a complete solution was found in the sense of a necessary and sufficient condition. It gives rise to a hierarchy of semi-definite programs corresponding to state extensions with polynomial constraints, and the positive-partial-transpose criterion as a first step, that generalizes and unifies on an abstract level previous approaches such as the Doherty- Parrilo-Spedalieri hierarchy. Flat extensions play a crucial role and are a systematic ingredient that allows us to prove separability of a state and obtain its explicit decomposition into a convex sum of product states. The approach is very flexible and general. It can accomodate naturally missing experimental data, symmetries, and subsystems of different dimensions.

Q 68.3 Fri 11:00 K 1.019

Characterising the distribution of quantum correlations via mutually unbiased bases — •Ali Asadian — TU Wien, Vienna

We know that an N-body quantum state can be reconstructed via the minimal sets of N-body probabilities corresponding to mutually unbiased bases (MUBs) measurements. It is useful to seek for a formulation where the state can be characterised via local one-body sets of MUBs and the k-body MUBs accounting for the correlations. For example, in the case of bipartite system this includes a complete set of local one-body MUBs for estimating the each party*s reduced states and an associated set of 2-body MUBs qualified for a complete estimation of 2-body correlations. I believe that such a classification gives a significant insight into the nature of the information content in N-body quantum states and how it is shared among the k-body correlations. A relevant property is the entanglement monogamy. It has been shown that anti-commutativity yields entanglement monogamy.

Q 68.4 Fri 11:15 K 1.019

Entanglement robustness of symmetric multiqubit states — •Antoine Neven, John Martin, and Thierry Bastin — CESAM Research Unit, Institut de Physique Nucléaire, Atomique et de Spectroscopie, Université de Liège, 4000 Liège, Belgium

Detecting the entanglement of a multipartite pure state is a task that can now be addressed using various tools, such as for example, negativity or generalised concurrences. Realising the same task with a mixed state is however still a challenge today. In a situation where some of the parties of a multipartite entangled pure state are lost, the question arises whether the residual mixed state keeps some of the initial entanglement. In this context, entangled pure states that after partial trace keep some entanglement are said to be robust against party loss and those that lose all entanglement (i.e. become separable) are said to be fragile against party loss. In this talk, we investigate the entanglement robustness against party loss of symmetric multiqubit states. We identify all the fragile states for the loss of 1 qubit and show that these fragile states exhibit a particular symmetry and are all SLOCC-equivalent. We also study robustness properties for multiple parties loss and treat exhaustively the case of symmetric states of 4 qubits.

Q 68.5 Fri 11:30 K 1.019

Characterization of quantum circuit in quantum-classical algorithms — •Andreas Woitzik[1], Panagiotis Kl. Barkoutsos[2], Ivano Tavernelli[2], Filip Wudarski[1], and Andreas Buchleitner[1] — [1]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Freiburg, Germany — [2]IBM Research ZRL, Rüschlikon, Switzerland

Recent advances in hybrid (quantum-classical) algorithms allow us to infer the ground states of Hamiltonians which are of relevance in quantum chemistry or for involved optimization problems. A possible approach is defined by a systematic search on the full Hilbert space via the sequential application of single-qubit rotations and multi-qubit entangling gates.

First results indicate that the high dimensionality of the molecular Hilbert space necessitates a large number of such entanglement blocks. The thus imposed critical circuit depth on state of the art quantum architectures with limited coherence times implies important restrictions for possible applications.

In order to reduce the number of gate operations, we investigate different entanglement schemes and evaluate their properties by means of a set of descriptors that includes entanglement quantifiers, site occupation, and convergence efficiency.

Q 68.6 Fri 11:45 K 1.019

Quantum states with a positive partial transpose are useful for metrology — •Géza Tóth[1,2,3] and Tamás Vértesi[4] — [1]Theoretical Physics, University of the Basque Country UPV/EHU, E-48080 Bilbao, Spain — [2]IKERBASQUE, Basque Foundation for Science, E-48011 Bilbao, Spain — [3]Wigner Research Centre for Physics, H-1525 Budapest, Hungary — [4]Institute for Nuclear Research, Hungarian Academy of Sciences, P.O. Box 51, H-4001 Debrecen, Hungary

We show that multiparticle quantum states that have a positive partial transpose with respect to all bipartitions of the particles can outperform separable states in linear interferometers. We introduce a powerful iterative method to find such states. We present some examples for multipartite states and examine the scaling of the precision with the particle number. Some bipartite examples are also shown that possess an entanglement very robust to noise. We also discuss the relation of metrological usefulness to Bell inequality violation. We find that quantum states that do not violate any Bell inequality can outperform separable states metrologically. We present such states with a positive partial transpose, as well as with a non-positive positive partial transpose.

Q 68.7 Fri 12:00 K 1.019

Estimating the amount of spatial correlations in quantum dynamics — •Lukas Postler[1], Ángel Rivas[2], Daniel Nigg[1], Esteban Martinez[1], Alexander Erhard[1], Roman Stricker[1], Philipp Schindler[1], Thomas Monz[1], Rainer Blatt[1,4], Miguel Angel Martín-Delgado[2], and Markus Müller[3] — [1]Institut für Experimentalphysik, Unviersität Innsbruck, Technikerstr. 25, A-6020 Innsbruck, Austria — [2]Departamento de Física Teórica I, Universidad Complutense — [3]Department of Physics, College of Science, Swansea University, Singleton Park, Swansea SA2 8PP, United Kingdom — [4]Institute for Quantum Optics and Quantum Information of the Austrian Academy of Sciences, A-6020 Innsbruck, Austria

Correlations in the dynamics of quantum mechanical systems are involved in many phenomena, like sub - and superradiance.Furthermore, correlations between errors also play an important role in quantum error correction schemes. A measure to quantify these correlations was introduced in [1]. To increase the applicability of this measure to intermediately and large sized quantum systems, more efficient methods to estimate spatial correlations in quantum dynamics are presented. An experimental realisation of the protocols in an trapped ion quantum information processor will be presented.

[1] A. Rivas and M. Müller, New J. Phys. 17, 062001 (2015).

Q 68.8 Fri 12:15 K 1.019

Initial System-Environment Correlations via the Transfer Tensor Method — Maximilian Buser[1,2], •Javier Cerrillo[1], Gernot Schaller[1], and Jianshu Cao[2] — [1]Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, D-10623 Berlin, German — [2]Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, Massachusetts 02139, USA

Open quantum systems exhibiting initial system-environment correlations are notoriously difficult to simulate. We point out that given a sufficiently long sample of the exact short-time evolution of the open system dynamics, one may employ transfer tensors for the further propagation of the reduced open system state. This approach is numerically advantageous and allows for the simulation of quantum correlation functions in hardly accessible regimes. We benchmark this approach against analytically exact solutions and exemplify it with the calculation of emission spectra of multichromophoric systems as well as for the reverse temperature estimation from simulated spectroscopic data. Finally, we employ our approach for the detection of spectral signatures of electromagnetically-induced transparency in open three-level systems.